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LGTPM REPORT NO. 93-R-02  
AFPEA PROJECT NO. 92-P-101

**AD-A268 554**



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QUALIFICATION TESTING OF THE NAVY COLLAPSIBLE  
EMBARKATION CONTAINER (CECON)

HQ AFMC/LGTPM  
AIR FORCE PACKAGING EVALUATION ACTIVITY  
WRIGHT-PATTERSON AFB, OH 45433-5999  
February 1993

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PROJECT NO. 92-101

TITLE: Qualification Testing of the Navy Collapsible  
Embarkation Container (CECON)

### ABSTRACT

At the request of the Carderock Division, Naval Surface Warfare Center, Bethesda, MD, the Air Force Packaging Evaluation Activity evaluated a modular collapsible aluminum container developed under contract with a commercial vendor by the Navy. The container configuration evaluated consisted of two aluminum end caps serving as top and bottom and two 18 inch collars and is secured to a 40 X 48 inch wood shipping pallet to an overall height of 41 inches by steel strapping. The advantage of the CECON container is that it can be disassembled, collapsed, and stacked for return shipment with greatly reduced volume. With a 1000 pound net weight load, the CECON container was subjected to a rough handling test series consisting of superimposed load, mechanical handling, repetitive shock vibration, 20 inch edgewise and cornerwise drop, 18 inch flat bottom drop, 10 feet per second pendulum impact, and blowing rain tests.

DTIC QUALITY INSPECTED 3

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## TABLE OF CONTENTS

	<u>PAGE</u>
Abstract.....	i
Table of Contents.....	ii
Introduction.....	1
Item Description.....	1
Test Equipment.....	2
Test Procedure.....	3
Conclusions and Results.....	4
Recommendations.....	7
Distribution List.....	8

## APPENDICES

Appendix 1: Test Plan.....	9
Appendix 2: Figures.....	10
Appendix 3: Test Data.....	11
Appendix 4: Interim Report of Preliminary Test 1.....	12
Appendix 5: Interim Report of Preliminary Test 2.....	13
Appendix 6: Interim Report of Preliminary Test 3.....	14
Appendix 7: Interim Report of Test.....	15

## INTRODUCTION

The objective of this test series is to qualify the collapsible embarkation container (CECON) for Level A shipping and storage in embarkation and shipboard service by the Navy. The test series was performed at the request of the Carderock Division, Naval Surface Warfare Center, Bethesda, MD by the Air Force Packaging Evaluation Activity. The tests listed in the Test Plan (Appendix 1) were derived from MIL-STD-648A, MIL-STD-810E, and Fed-Std-101C, and are commonly applied to special purpose containers to establish Level A shipping and storage capability. The test methods constitute both procedure for performing the tests and performance criteria for evaluating container acceptability. Reference is made to Appendices 4, 5, 6, and 7 for the various container configurations tested and the respective test results. The revised test plan which resulted from reduction of the net test load to 1021 pounds and effort to minimize the adverse effect of cumulative pallet damage on subsequent tests is listed in the body of Appendix 7.

## ITEM DESCRIPTION

The CECON container configuration tested in accordance with the amended test plan consisted of two caps, two 18 inch high collapsible collars, a 4 way partial wing style three stringer hardwood pallet, and 3/4 X 0.023 inch regular duty steel strapping and regular duty strapping seals applied in accordance with MIL-STD-147. All structural forces configuring the assembled container are developed either by the steel strapping in tension, interlocking bearing reactions of the caps and the collars, or compressive bearing reactions of the cap or collar on the pallet. The caps and collars are fabricated from extruded one inch thick double wall aluminum panels. The collars are hinged at the four corners and at midspan on two opposite faces to allow folding into a four layered 48 X 18 X 4 inch rectangular configuration for return shipment. The collapsed and stacked container on its shipping pallet would then occupy a volume of 48 X 40 X 11 = 21120 cubic inches for a reduction in cube by approximately 3/4 its assembled volume.

All components were either supplied or specified by the Carderock Division. The aluminum CECON container components were manufactured by a commercial vendor, and supplied through the Carderock Division. The 4 way partial wing style three stringer hardwood pallet (NSN 3990-01-041-8803) and the steel strapping (NSN 8135-00-281-4069) were obtained through the Federal Supply System.

The steel strapping securing the CECON container to the pallet was applied as two lengthwise and two girthwise bands passing through pallet strapping notches and under deck boards. As one steel seal did not develop 75 % joint efficiency of the steel strapping provided, each strap joint was formed with two regular duty steel seals each of which received two pairs of notches when sealed. The ultimate tensile strength of the steel strapping provided was measured to be 2239 pounds and of the strapping joint with two steel seals was measured to be 2100 pounds. ASTM D 3953 - 91, Standard Specification for Strapping, Flat Steel and Seals, requires that regular duty steel strapping 3/4 X .023 inch shall have a minimum breaking strength of 1380 pounds and for a double notch joint, a minimum joint strength of 75 %.

The container was loaded to a gross load of 1255 pounds and a net load of 1021 pounds using 10 X 10 X 8 inch fiberboard boxes filled with sand. The lower tier consisted of 16 loose 10 X 10 X 8 boxes with a mean weight of 46 pounds, 3 loose 10 X 10 X 5 boxes with a mean weight of 23 pounds, and an empty 5 X 5 X 6 box. The upper tier consisted of 16 loose 10 X 10 X 8 inch boxes with a mean weight of 13.4 pounds, 3 empty 10 X 10 X 5 inch boxes and an empty 5 X 5 X 6 box. The boxes were interlocked on each tier to form a tight packed pattern. The load center of gravity was located above the base centroid of the container. The load was uniformly and symmetrically distributed about the base centroid of the container. Container interior dimensions were L X W X H, 46.1 X 38.2 X 34.2 inches. Assembled container exterior dimensions were 48.2 X 40.1 X 41.1 inches on the pallet.

#### TEST EQUIPMENT

The following test equipment was used in this test:

Item	Manufacturer	Model	Serial
Camera	Polaroid	Spectra	
Overhead Crain, 5000#	Ohio Crain & Hoist		
Forklift Truck, 5000#	Pettibone Mercury	401S	117774
Rain Salt-Fog Chamber	Harshaw Chemical		
Scale, Platform	Howe		A057229
Scale, Platform	Howe		A057232
Steel Tape, 50 foot	Roe International		
Steel Tape, 6 foot	Zippo		
Universal Test Machine	Instron Corp.	TTG	1597
Vibration Machine	L.A.B. Division	5000-96B	56801
Watch	Bulova	Accutron	

## TEST PROCEDURE

The assembled and loaded CECON container was subjected to the following tests in the order listed during the period of 26-28 October, 1992. Conditions of test are stated to indicate amendment to the initially proposed test plan.

TEST NO.	TEST METHOD	TEST TITLE AND PARAMETERS	STATUS
1.	Container Set-up	Dimensions: 48.2 X 40.1 X 41.1 Net Weight: 1021 pounds Gross Weight: 1255 pounds Pallet: 40 X 48 inches	
2.	Fed-Std-101C Method 5016.1	Superimposed Load Test (Stackability with Dunnage) Level A. Loaded 9155 lbs.	Passed
3.	Fed-Std-101C Method 5011.1 (6.2) (6.5) (6.6)	Mechanical Handling Test.  Lifting and transporting by forklift truck Pushing Towing	Passed
4.	Fed-Std-101C Method 5019.1	Vibration (Repetitive Shock) Test: 4.4 Hz, 1.0 in DA, 2 hrs.	Passed
5.	Fed-Std-101C Method 5008.1	Edgewise Drop (Rotational) Test, Level A. One drop on each bottom edge from 20 inch drop height.	Passed
6.	Fed-Std-101C Method 5005.1	Cornerwise Drop (Rotational) Test, Level A. One drop on each bottom corner from 20 inch height.	Passed
7.	MIL-STD-648A 5.2.8	Transfer at Sea Shock Test. 18 inch flat bottom drop.	Passed
8.	Fed-Std-101C Method 5012	Pendulum Impact Test. One impact on each side at 10 ft/sec impact velocity.	Passed
9.	MIL-STD-810E Method 506.3 Procedure I	Rain, Blowing Rain. 5 in/hr rain rate, 40 mph wind on each side for 30 minutes	Failed

## CONCLUSIONS AND RESULTS

### Test No. 1, Container Set-up.

The assembled container exterior dimensions are L X W X H 48.2 X 40.1 X 41.1 inches. Container net weight is 1021 pounds. Container gross weight is 1255 pounds. Pallet base dimensions are 40 X 48 inches.

### Test No. 2, Fed-Std-101C, Method 5016.1, Superimposed Load Test (Stackability with Dunnage), Level A.

The test container sustained the required superimposed test load of 9155 pounds for 1 hour without sustaining permanent deformation or damage; therefore, the test container complies with the requirements of Method 5016.1.

### Test No. 3, Fed-Std-101C, Method 5011.1, Mechanical Handling Test.

The test container was lifted from the side by a forklift truck with 40 inch length tines transported over the prescribed 100 foot length course in approximately 23 seconds (3 miles per hour) and returned. The test container was lifted by the end, transported over the prescribed course, and returned.

The test container with its skids resting on asphalt pavement was pushed by a forklift truck with its tines accessing from the container side for a distance of 35 feet in approximately 85 seconds. The test container was accessed from its end and pushed 35 feet in approximately 85 seconds.

By means of a strap passing around the pallet, the test container was towed by a forklift a distance of 100 feet on asphalt pavement in approximately 23 seconds. The test container was rotated 90 degrees and towed a distance of 100 feet in approximately 23 seconds.

As a consequence of the above handling, the only non-critical damage sustained was to the pallet which incurred minor bottom board abrasion and cracking and separation of a small piece of the stringer end on corner 2 - 5. The test container complies with the requirements of Method 5011.1.

Test No. 4, Fed-Std-101C, Method 5019.1, Vibration  
(Repetitive Shock) Test.

After 2 hours vibration at a frequency of 4.4 Hz and a double-amplitude displacement of 1.0 inch with a 1/16 inch feeler gauge passing under the pallet, the container incurred no visible damage. The strapping remained tight. The container remained centered on the pallet. The test container complies with the requirements of Method 5019.1.

Test No. 5, Fed-Std-101C, Method 5008.1, Edgewise Drop  
(Rotational) Test.

After receiving one rotational edgewise drop from a height of 20 inches on each bottom edge, the container incurred no visible damage. The strapping remained tight. The container remained centered on the pallet. The test container complies with the requirements of Method 5008.1.

Test No. 6, Fed-Std-101C, Method 5005.1, Cornerwise Drop  
(Rotational) Test.

After receiving one rotational cornerwise drop from a height of 20 inches on each bottom corner, the container incurred the following damage to its pallet: (a) Bottom board is cracked between stringers of corner 4 - 6. (b) Bottom board exterior to side stringer is cracked on corner 2 - 5. (c) Bottom board exterior to side stringer is broken on corner 4 - 5. (d) Bottom board on side 2 is separated from pallet due to the cracking and separating of the three stringer ends to which attached. and (e) End of center stringer on side 4 is cracked. As a forklift truck can access the pallet and lift the container from all four sides, the pallet damage is not determined to be critical. The strapping remained tight. The container remained centered on the pallet. The test container complies with the requirements of Method 5008.1.

Test No. 7, MIL-STD-648A, 5.2.8, Transfer at Sea Shock Test.

After receiving one flat bottom drop from a height of 18 inches, the container incurred no further damage. The strapping remained tight. The container remained centered on the pallet. The test container complies with the requirements of MIL-STD-648A, 5.2.8.



Test No. 8, Fed-Std-101C, Method 5012, Pendulum Impact Test.

After receiving one 10 foot per second velocity pendulum impact on each side, the container sustained damage to the corner hinges and shifting of the upper collar with respect to the lower collar in the bearing plane of the two collars. The corner hinges on the impacting face incurred inelastic deformation which caused the hinge assembly seals to open in attaching rivet lines. Notably, the four corner hinges were sprung, the hinge plates through which rivets passed buckled and warped between rivets, and attaching rivets withdrew allowing these seams to open on the bottom collar. Even so, the deformed corner hinges appeared to retain much of their mechanical strength; therefore, with respect to mechanical strength, the hinge damage is not determined to be critical or to cause container failure. After the rain test, both the upper and lower collars were folded and unfolded without interference from the corner hinge deformation. To a lesser degree, corner hinge deformation and assembly seal opening occurred on the upper collar also.

Upper collar shifting with respect to the lower collar resulted in 1/2 inch displacement in the direction of the pendulum velocity on each of the four side impacts with the final consequence being that the upper collar became recentered upon the lower collar. The upper collar shifting was largely a consequence of upper collar hinge deformation both elastic and inelastic which allowed distortion of the upper collar geometry and clearance between the lower collar and the upper collar fairing skirt. The lower collar remained constrained by the upper collar fairing skirts which were not damaged by the resulting transverse bearing forces. The container column load bearing properties relating to stacking strength did not appear to be critically compromised.

After four side impacts, the container remained centered on the pallet, and container strapping remained tight and secure. Pendulum impacts did not cause further pallet damage. The test container complies with the requirements of Fed-Std-101C, Method 5012.

Test No. 9, MIL-STD-810E, Method 506.3, Rain, Procedure I, Blowing Rain.

After the test container incurred 5 inches per hour rain and 40 miles per hour wind at 18 degrees Centigrade for a 30 minutes exposure period on each side, test results indicate that the CECON container is not watertight at this point in the test sequence. Approximately one quart of leakage is

estimated to have entered the container through the eight opened corner hinges, between the top gasket-collar seam, and between the upper-lower collar seam. Test related cause of the leakage would be springing and opening of the collar corner hinges by rotational drop and pendulum impact testing and top cap gasket compression set resulting from the super-imposed load, vibration, and drop testing. The gaskets for both the top and bottom caps incurred cumulative compression set from one-eighth inch initial thickness to 0.01 to 0.03 inch final thickness during the test series ; consequently, the gaskets did not seal during the rain test. The test container does not comply with the requirements of MIL-STD-810E, Method 506.3, Rain, Procedure I, Blowing Rain.

#### Post-test General Inspection.

Test induced container damage is cumulative over the test series; however, the container appears to be serviceable and capable of being transported and conveying its contents to its final destination. Collar corner hinge damage and cap gasket compression set allow water leakage during the rain test, but appear not to critically degrade container structural integrity. Pallet damage is extensive, but confined to the lower deck boards and stringers. After the rain test, the pallet was accessed from all four sides, and the container transported by forklift truck to demonstrate that the pallet was serviceable. After reaching the final destination, a damaged pallet could be replaced, and the refurbished container continue to be used. The container is centered on the pallet. The container steel strapping is tight and secure. The container was disassembled, and the collars folded, stacked, and unfolded without interference from the damaged corner hinges. Damage or deformation to the caps or collars that would interfere with container assembly, disassembly, or disassembled stacking or shipment was not present.

#### RECOMMENDATIONS

As test results justify the following, it is recommended that the CECON container version evaluated be used as a level A shipping and storage container for items not requiring watertight protection in continental United States, embarkation, shipboard, and overseas service with a net load of up to 1000 pounds.

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**APPENDIX 1**

**TEST PLAN**



AIR FORCE PACKAGING EVALUATION ACTIVITY (Container Test Plan)						AFPEA PROJECT NUMBER 92-101	
CONTAINER SIZE (L x W x D) (INCHES)		WEIGHT (LBS)		CUBE (CU. FT.)	QUANTITY	DATE	
INTERIOR:	EXTERIOR:	GROSS:	ITEM:				
46.1x38.2x34.2	48.4x40.5x36.8	4199	4000	41.7	2	3 Mar 92	
ITEM NAME General Cargo				MANUFACTURER <div style="background-color: black; width: 100px; height: 1em;"></div>			
CONTAINER NAME CECON Collapsible Aluminum Container					CONTAINER COST \$500.00		
PACK DESCRIPTION CECON: 2 caps and 2 ea 18 in collars and 4000 lb. load							
CONDITIONING None							
TEST NO.	REF STD/SPEC AND TEST METHOD OR PROCEDURE NO'S	TEST TITLE AND PARAMETERS	CONTAINER ORIENTATION	INSTRUMENTATION			
1.		Dimensions, Weight	Fully assembled and loaded	Ruler Scale			
2.	Fed-Std-101C Method 5019.1	Vibration (Repetitive Shock) Test	Ambient temp				
3.	Fed-Std-101C Method 5005.1	Cornervise Drop (Rotational) Test, Level A, 12 inch drop height	Ambient temp One drop on each bottom corner	Ruler			
4.	Fed-Std-101C Method 5008.1	Edgewise Drop (Rotational) Test Level A, 12 inch drop height	Ambient temp One drop on each bottom edge	Ruler			
5.	Fed-Std-101C Method 5012	Pendulum Impact Test, 10 feet per second impact velocity	One impact on each side	Ruler			
6.	Fed-Std-101C Method 5011.1 (6.2) (6.5) (6.6)	Mechanical Handling Test Lifting and transporting by forklift truck. Pushing Towing	Ambient temp Upright				
COMMENTS: The test load consisting of 4000 lbs of stacked lead blocks is loose.							
PREPARED BY: <i>Edward P. Moravec Jr.</i> Edward P. Moravec Jr, Physicist				APPROVED BY: <i>Larry Wood</i> Larry Wood, Chief, Materials Br.			

AIR FORCE PACKAGING EVALUATION ACTIVITY (Container Test Plan)						AFPEA PROJECT NUMBER 92-101	
CONTAINER SIZE (L x W x D) (INCHES)		WEIGHT (LBS)		CUBE (CU. FT.)	QUANTITY	DATE	
INTERIOR: 46.1x38.2x34.2    EXTERIOR: 48.4x40.5x36.8		GROSS: 4199    ITEM: 4000		41.7	2	3 Mar 92	
ITEM NAME General Cargo				MANUFACTURER [REDACTED]			
CONTAINER NAME CECON Collapsible Aluminum Container					CONTAINER COST \$500.00		
PACK DESCRIPTION CECON: 2 caps and 2 ea 18 in collars and 4000 lb. load							
CONDITIONING None							
TEST NO.	REF STD/SPEC AND TEST METHOD OR PROCEDURE NO'S	TEST TITLE AND PARAMETERS		CONTAINER ORIENTATION	INSTRUMENTATION		
7.	Fed-Std-101C Method 5016.1	Superimposed - Load Test (Stackability with Dunnage) Level A		On pallet and loaded to 29275 lbs for 1 hour.			
8.	MLL-Std-810E Method 506.3 Procedure I	Rain, Blowing Rain		4 in/hr rain 40 mph wind on each side for 30 min.	rain gauge air speed indicator		
9.	MLL-Std-648 5.2.8	Transfer at 5 ea Shock Test. 18" flat bottom drop.		On pallet and loaded	Ruler.		
COMMENTS:							
PREPARED BY: Edward P. Moravec Jr, Physicist				APPROVED BY: Larry Wood, Chief, Materials Br.			

APPENDIX 2

FIGURES



Figure 1. Four Way Partial Wing Style Three Stringer Hardwood Pallet (NSN 3990-01-041-8803).



Figure 2. Collapsed CECON Container on Pallet.



Figure 3. Partially Assembled CECON Showing Test Load.

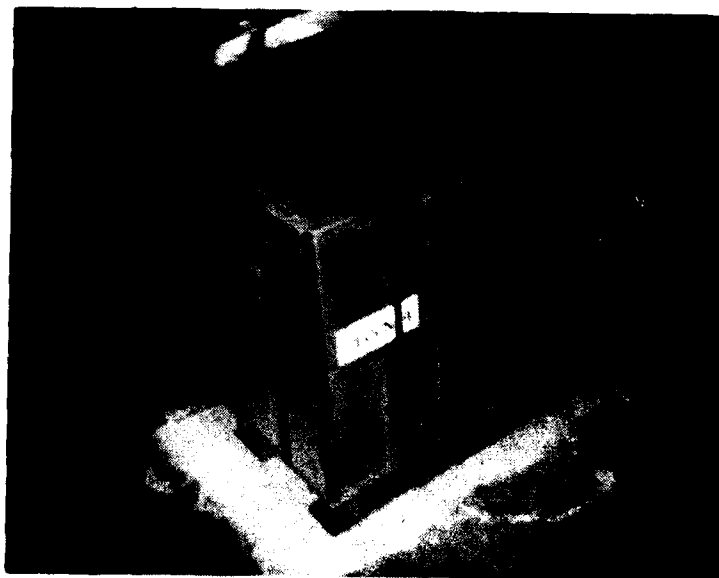


Figure 4. Fully Assembled CECON Container Strapped to Pallet.

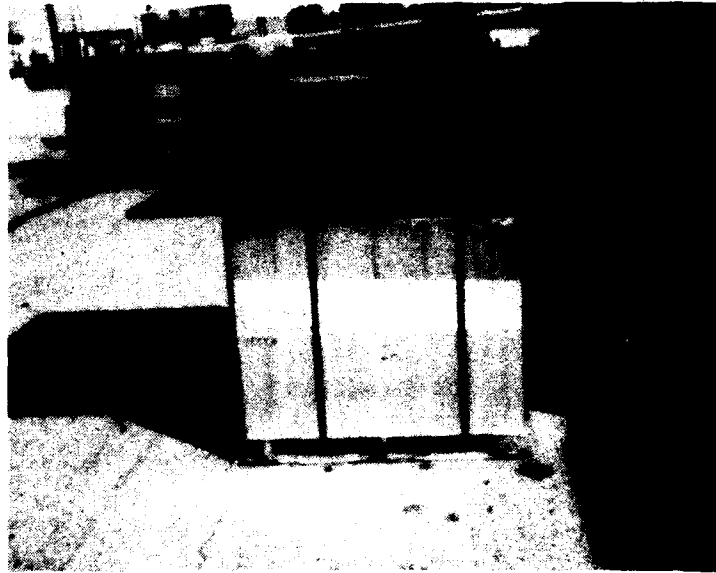


Figure 5. Superimposed Load Test.



Figure 6. Mechanical Handling Test: Lifting and Transporting by Forklift Truck.



Figure 7. Mechanical Handling Test: Pushing.

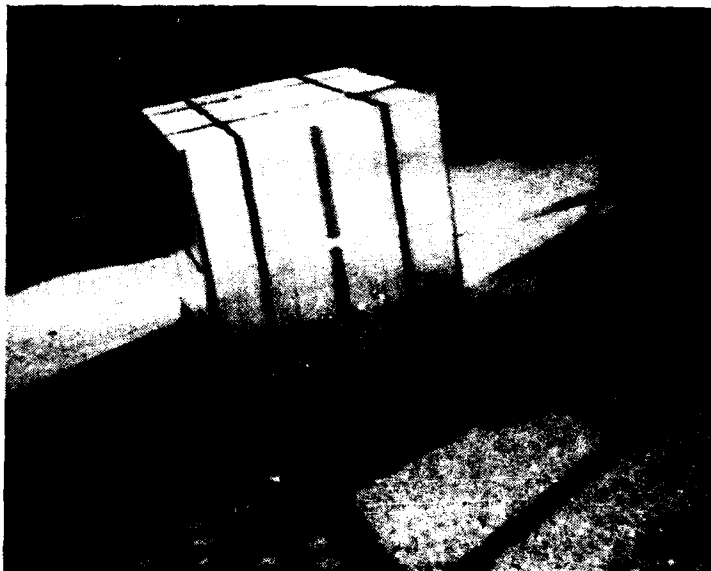


Figure 8. Mechanical Handling Test: Towing.

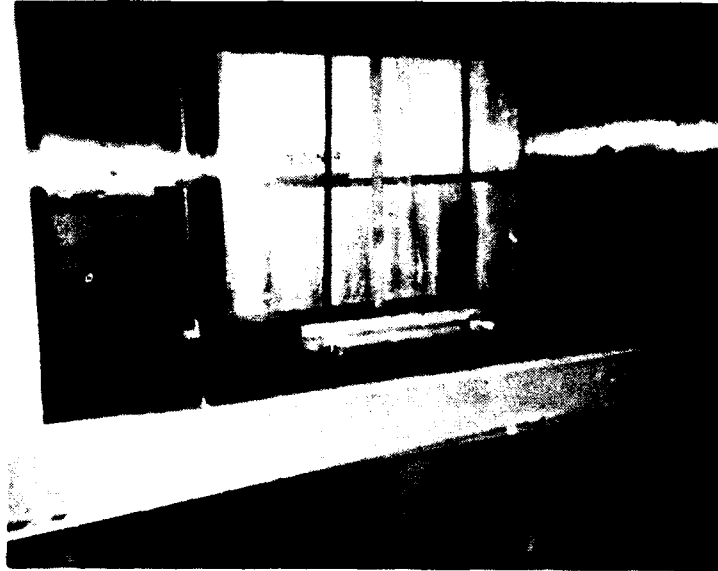


Figure 9. Vibration Test.



Figure 10. Edgewise Drop Test.



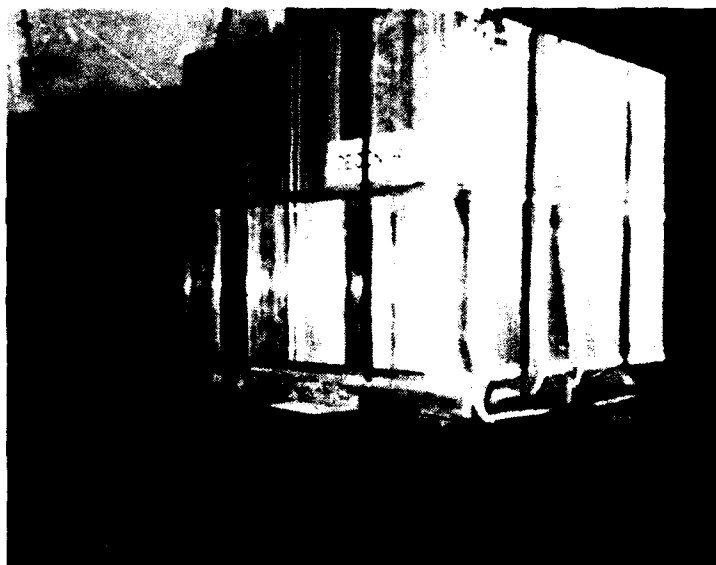


Figure 11. Cornerwise Drop Test.

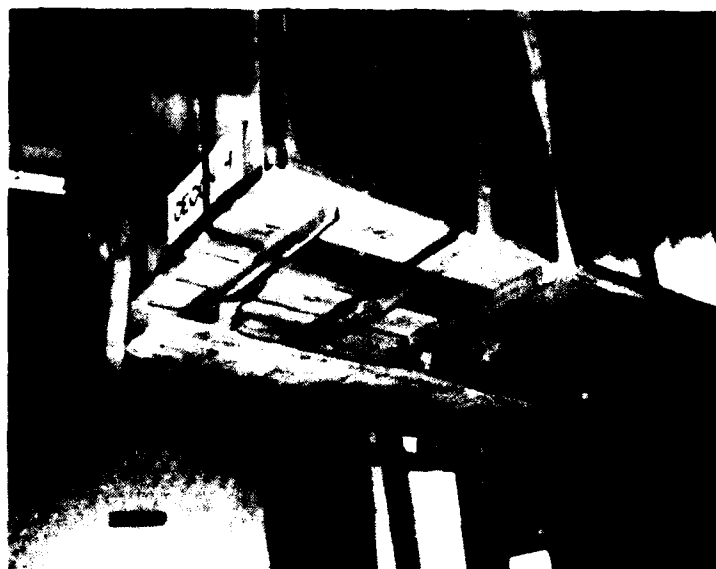


Figure 12. Pallet Damage Resulting from Cornerwise Drop Testing.

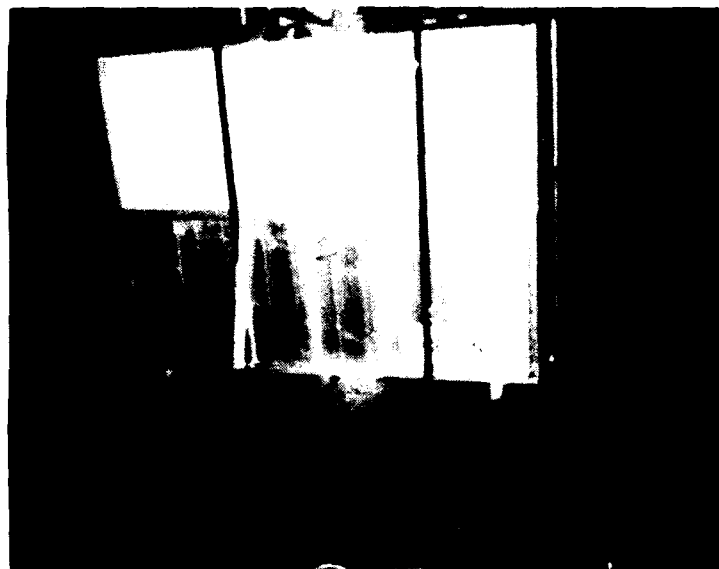


Figure 13. Transfer at Sea Shock Test (18 Inch Flat Drop).



Figure 14. Pendulum Impact Test.

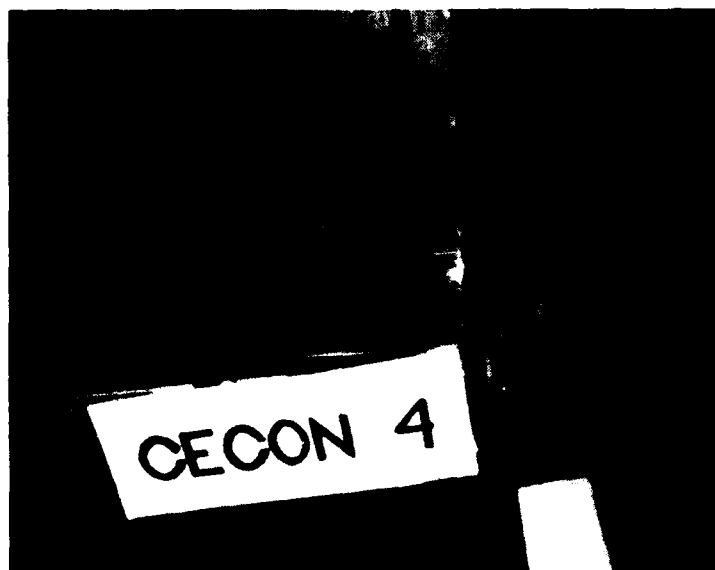


Figure 15. Lower Collar Corner 2-6 Hinge Damage Resulting from 10 ft/sec Pendulum Impact on Side 2.



Figure 16. Lower Collar Corner 2-5 Hinge Damage Resulting from 10 ft/sec Pendulum Impact on Side 5. Note Shifting of Upper Collar with Respect to Lower Collar.



Figure 17. Lower Collar Corner 4-5 Hinge Damage Resulting from 10 ft/sec Pendulum Impact on Side 4.



Figure 18. Lower Collar Corner 4-6 Hinge Damage Resulting from 10 ft/sec Pendulum Impact on Side 6.

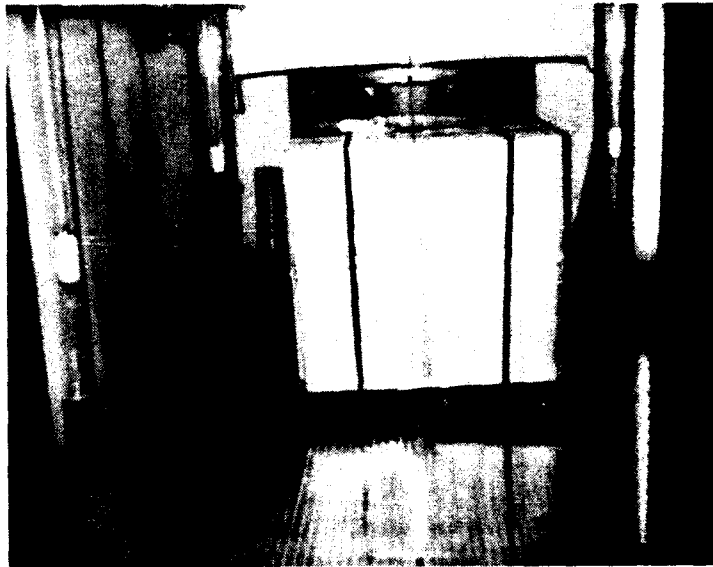


Figure 19. Rain, Blowing Rain Test.

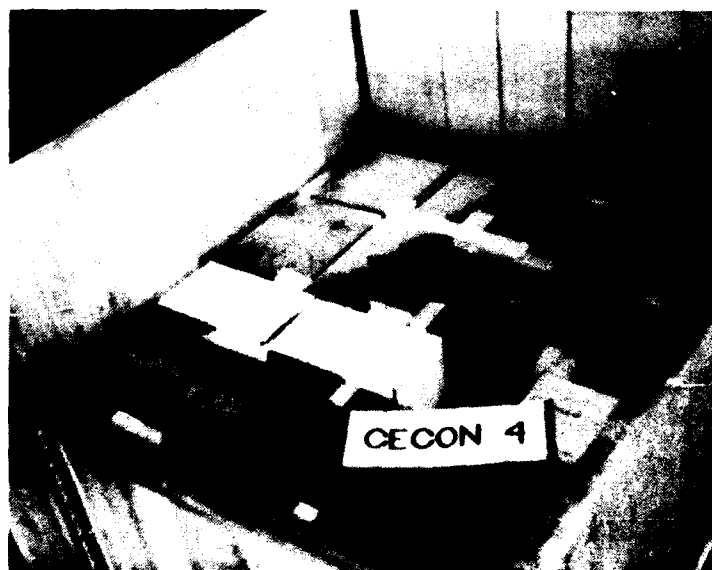


Figure 20. Wetting of Upper Tier of Load due to Rain Test.



Figure 21. Wetting of Lower Tier of Load due to Rain Test.



Figure 22. Post Test Inspection: Disassembled Container with Upper and Lower Collars Folded.

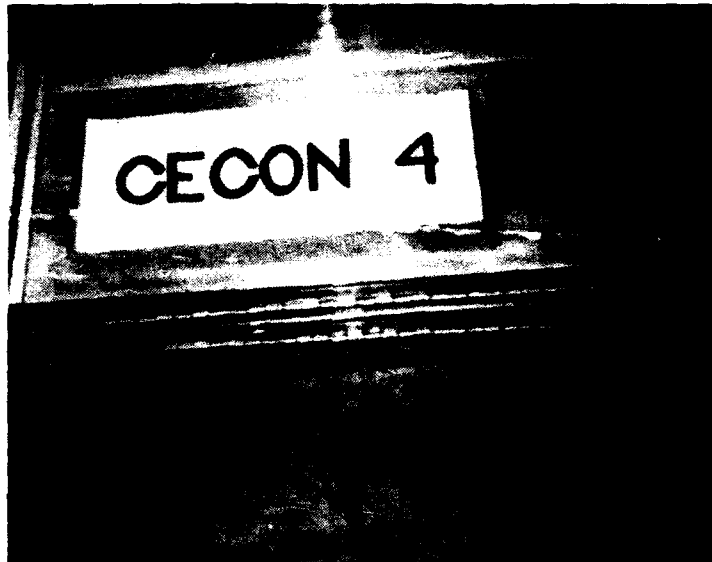


Figure 23. Post Test Inspection: Lower Collar Hinge Damage.



Figure 24. Post Test Inspection: Lower Collar Hinge Damage, Opposite Side to Figure 23.



Figure 25. Hardwood Pallet Used in Test Series 1 and 2.

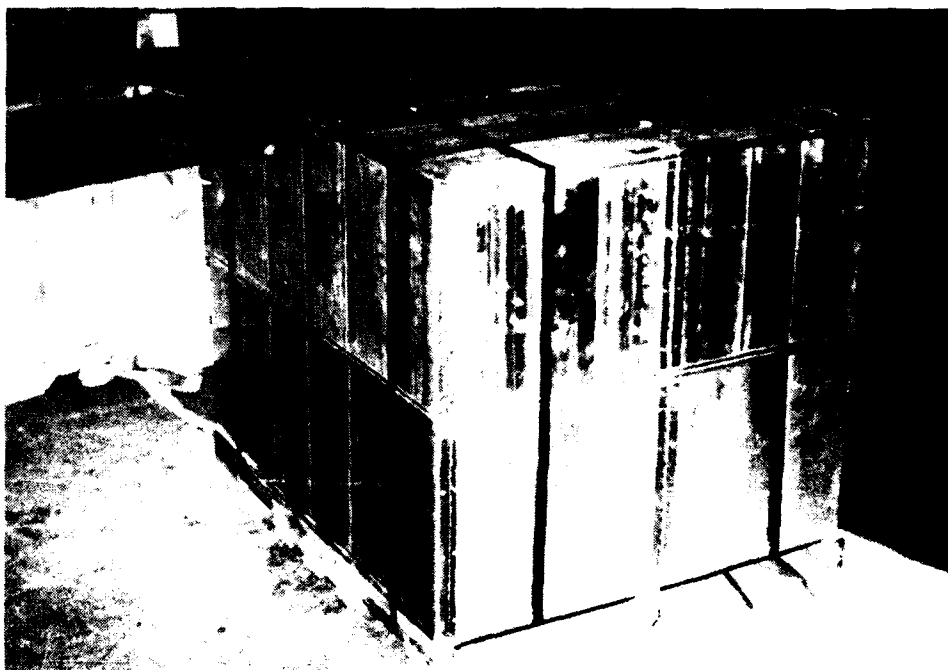


Figure 26. Test Series 2, Assembled CECON Container.



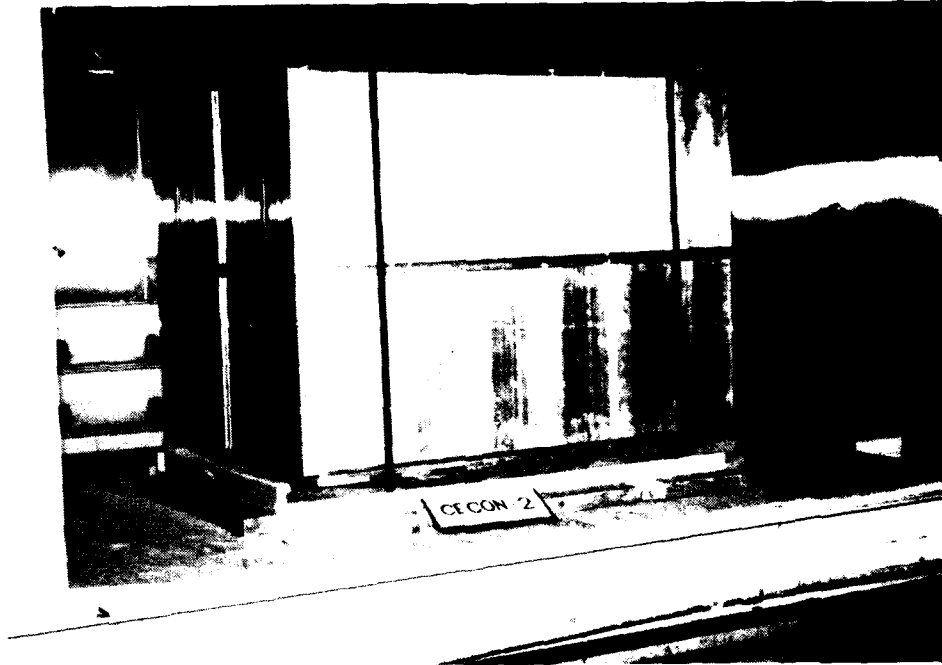


Figure 27. Test Series 2: Vibration Test.



Figure 28. Test Series 2: Cornerwise Drop Test Damage.

**APPENDIX 3**

**TEST DATA**

Test 4, Sequence 2, Fed-Std-101C, Method 5016.1, Superimposed Load Test (Stackability with Dunnage), Level A, 9155 lb. Load.

Dimension Location	Dimension Orientation	Initially Loaded (Inches)	Loaded One Hour (Inches)	Unloaded Post-Test (Inches)
Side 2	Horizontal	48 1/4	48 1/4	48 1/8
Side 5	Horizontal	40	40	40
Side 4	Horizontal	48 1/16	48 1/8	48 1/8
Side 6	Horizontal	40	40	40
Corner 2-5	Vertical	40 7/8	40 7/8	41
Corner 4-5	Vertical	40 7/8	40 7/8	40 15/16
Corner 4-6	Vertical	40 7/8	40 7/8	40 15/16
Corner 2-6	Vertical	40 7/8	40 7/8	41
Diagonal Side 5	Top 2-5 to Bottom 4-5	57	57	57 1/8
Diagonal Side 4	Top 4-5 to Bottom 4-6	62 7/8	63	62 7/8
Diagonal Side 6	Top 4-6 to Bottom 2-6	57 1/8	57 1/8	57
Diagonal Side 2	Top 2-6 to Bottom 2-5	63	63 1/8	62 7/8

NOTE 1: Measurements containing a vertical component are taken from the pallet bottom to the container top.

NOTE 2: For test group 4, side 2 is on a 48 inch side opposite side 4, and side 5 is on a 40 inch side containing a center hinge and opposite side 6 which is on the container right. Progressing in clockwise rotation about the container, the side identifying number sequence is 2, 6, 4, and 5.

Test 4, Sequence 4, Fed-Std-101C, Method 5019.1, Vibration (Repetitive Shock) Test.

Container Axis	Time (Min)	Table Input	
		Frequency (Hz)	Displacement (Inches D.A.)
Vertical	120	4.4	1.0

NOTE 1: At the table input frequency of 4.4 Hz, a 1/16 inch feeler gauge would just pass between the pallet bottom and the table deck.

Test 4. Steel Strapping Ultimate Strength and Notched Seal Spliced Joint Efficiency Tests.

Specimen	Strapping (Inches)	Length (Inches)	Number of Seals	Notch Pairs per Seal	Ultimate Tensile Strength (Pounds)
Strap 1	3/4 X .023	5 3/4	--	--	2251
Strap 2	3/4 X .023	5 3/4	--	--	2221
Strap 3	3/4 X .023	5 3/4	--	--	2246
Joint 4	3/4 X .023	5 3/4	1	2	1347
Joint 5	3/4 X .023	5 3/4	1	2	1328
Joint 6	3/4 X .023	5 3/4	2	2	2080
Joint 7	3/4 X .023	5 3/4	2	2	2119

Test 2. Steel Strapping Ultimate Strength and Crimped Seal Spliced Joint Efficiency Tests.

Specimen	Strapping (Inches)	Length (Inches)	Number of Seals	Crimp Pairs per Seal	Ultimate Tensile Strength (Pounds)
Strap 1	3/4 X .020	6	--	--	2119
Strap 2	3/4 X .020	6	--	--	2114
Strap 3	3/4 X .020	6	--	--	2026
Joint 4	3/4 X .020	6	1	2	219
Joint 5	3/4 X .020	6	1	2	208
Joint 6	3/4 X .020	6	1	2	208

Note 1: The crimping tool used to crimp the 1 X 3/4 inch regular duty seal was in good condition and of the correct size and type. The tool formed two crimp pairs per seal which appeared to be functional and as required by ASTM D4675, Standard Guide for Selection and use of Flat Strapping Materials and ASTM D3953, Standard Specification for Strapping, Flat Steel and Seals. The strapping appears to be only lacquer coated, but may also be very lightly wax coated which if so, may account for the very low joint efficiency of 10.1 percent.

APPENDIX 4  
INTERIM REPORT OF PRELIMINARY TEST 1

INTERIM REPORT OF PRELIMINARY TEST 1 FOR THE COLLAPSIBLE  
EMBARKATION CONTAINER (CECON)

The container configuration tested in accordance with the attached test plan consisted of two caps, two 18 inch high collapsible collars, a 4 way partial flush style three stringer hardwood MIL-P-52999 pallet and 1 1/4 X 0.035 inch heavy duty steel strapping and seal (FSN 7536-00-705-2828). The steel strapping was applied as two lengthwise and two girthwise bands passing through forklift notch openings and under deck boards. Each strap joint was formed with one steel seal which received two pairs of notches when sealed. The CECON container components were manufactured by commercial vendor and forwarded by the Carderock Division for test. The 4 way partial flush style three stringer hardwood pallet was obtained from a DoD stock. The steel strapping and seals were obtained from our shop. The container was loaded to a gross load of 4272 pounds and a net load of 4038 pounds using 10 X 10 X 8 inch fiberboard boxes filled with sand to a weight of 47 pounds and 50 pound lead blocks. Container interior dimensions were L X W X H, 46.1 X 38.2 X 34.2 inches. Assembled container dimensions were 48.2 X 40.1 X 41.2 inches on the pallet. The container gaskets were modified by Cincinnati Case Co at Navy request.

The assembled and loaded CECON container was subjected to the following tests in the order listed during the period of 15-16 June, 1992. A pass or fail status is indicated with explanatory comment as appropriate.

TEST NO.	TEST METHOD	TEST TITLE AND PARAMETERS	STATUS
1.	Container Set-up	Dimensions: 48.2 X 40.1 X 41.2 inches Net Weight: 4038 pounds Gross Weight: 4272 pounds Pallet: 40 X 48 inches	
2.	Fed-Std-101C Method 5019.1	Vibration (Repetitive Shock) Test: 4.5 Hz, 1.0 in DA, 2 hrs.	Passed <sup>1</sup>
3.	Fed-Std-101C Method 5005.1	Cornerwise Drop (Rotational) Test, Level A. One drop on each bottom corner from 12 inch height.	Failed <sup>2</sup>

NOTE 1: Pallet deterioration which at this point is non-critical has resulted from the vibration test. Where bearing on bottom boards, the stringers have compressed and crushed. On one end, the center stringer is compressed, crushed, and

cracked. At the junction of the center stringer and center bottom boards, charring has resulted from the heat generated by the vibration.

NOTE 2: Critical pallet failure occurred on the first cornerwise drop. The stringer supported by the six and twelve inch orienting blocks cracked midspan more than three fourths of its vertical height. The bottom board supported by the twelve inch block was cracked and forced into contact with the above deck board. The stringer on the opposite side is completely crushed and splintered on the impacted corner to the extent that it affords no support to the bottom board and it is largely displaced from between the bottom and deck boards. Cumulative pallet deterioration from vibration and drop testing at this point is determined to be critical, and has rendered the pallet unserviceable, therefore; this test iteration was discontinued. The steel strapping remained tight. The CECON container remained closed and centered on the pallet. On the bottom collar, the four corner hinges incurred appreciable springing and deformation in the lower six inches, however; this hinge deformation is not sufficient to be critical. On two sides, strapping has permanently deformed the weather stripping fairing.

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APPENDIX 5  
INTERIM REPORT OF PRELIMINARY TEST 2



**INTERIM REPORT OF PRELIMINARY TEST 2 FOR THE COLLAPSIBLE  
EMBARKATION CONTAINER (CECON)**

The container configuration tested in accordance with the amended test plan consisted of two caps, two 18 inch high collapsible collars, a 4 way partial flush style three stringer hardwood MIL-P-52999 pallet, and 3/4 X 0.020 inch regular duty steel strapping and regular duty strapping seals. The steel strapping was applied as two lengthwise and two girthwise bands passing through forklift notch openings and under deck boards. Each strap joint was formed with one regular duty steel seal which received two pairs of crimps when sealed. The ultimate tensile strength of the strapping was measured to be 2086 pounds and of the strapping joint was measured to be 211 pounds. The CECON container components were manufactured by commercial vendor, and forwarded for test by the Carderock Division. The 4 way partial flush style three stringer hardwood pallet was obtained from DoD stock. The steel strapping and seals were obtained from our shop. The container was loaded to a gross load of 1273 pounds and a net load of 1034 pounds using 10 X 10 X 8 inch fiberboard boxes filled with sand to weights of between 12 to 50 pounds. Container interior were L X W X H, 46.1 X 38.2 X 34.2 inches. Assembled container dimensions were 48.2 X 40.1 X 41.1 inches on the pallet.

The assembled and loaded CECON container was subjected to the following tests in the order listed during the period of 18 June, 1992. Conditions of test are stated to indicate amendment to the initially proposed test plan (Attachment 1). A pass or fail status is indicated with explanatory comment as appropriate.

TEST NO.	TEST METHOD	TEST TITLE AND PARAMETERS	STATUS
1.	Container Set-up	Dimensions: 48.2 X 40.1 X 41.1 inches Net Weight: 1034 pounds Gross Weight: 1273 pounds Pallet: 40 X 48 inches	
2.	Fed-Std-101C Method 5019.1	Vibration (Repetitive Shock) Test: 4.4 Hz, 1.0 in DA, 2 hrs.	Passed
3.	Fed-Std-101C Method 5005.1	Cornerwise Drop (Rotational) Test, Level A. One drop on each bottom corner from 20 inch height.	Failed <sup>1</sup>

NOTE 1: Container failure occurred on the first corner drop. All four strapping bands failed at the lap joint

by completely pulling free of the seal. The upper container then slid eight inches across the bottom cap toward the side intersecting the impacted corner and opposite the side supported by the six and twelve inch orienting blocks. For the corner supported by the twelve inch block, the bottom pallet board was largely broken between corner and center stringers by the twelve inch block. Failure of the strapping joints is attributed to low joint efficiency resulting from the use of one regular duty crimped seal with two crimp pairs per joint and the possibility that the strapping was either coated or waxed.

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APPENDIX 6  
INTERIM REPORT OF PRELIMINARY TEST 3

INTERIM REPORT OF PRELIMINARY TEST 3 FOR THE COLLAPSIBLE  
EMBARKATION CONTAINER (CECON)

The container configuration tested in accordance with the amended test plan consisted of two caps, two 18 inch high collapsible collars, a 4 way partial wing style three stringer hardwood pallet, and 3/4 X 0.023 inch regular duty steel strapping and regular duty strapping seals applied in accordance with MIL-STD-147. All components were either supplied or specified by the Navy, Carderock Division, Naval Surface Warfare Center, Bethesda, MD (Mr. C. Emberger). The steel strapping (NSN 8135-00-281-4069) was applied as two lengthwise and two girthwise bands passing through pallet strapping notches and under deck boards. Each strap joint was formed with two regular duty steel seals each of which received two pairs of notches when sealed. The ultimate tensile strength of the strapping was measured to be 2239 pounds and of the strapping joint was measured to be 2100 pounds. The CECON container components were manufactured by commercial vendor and forwarded for test by the Carderock Division. The 4 way partial wing style three stringer hardwood pallet (NSN 3990-01-041-8803) was obtained through the Federal Supply System. The container was loaded to a gross load of 1256 pounds and a net load of 1021 pounds using 10 X 10 X 8 inch fiberboard boxes filled with sand to weights of between 12 to 50 pounds. Container interior dimensions were L X W X H, 46.1 X 38.2 X 34.2 inches. Assembled container exterior dimensions were 48.2 X 40.1 X 41.1 inches on the pallet.

The assembled and loaded CECON container was subjected to the following tests in the order listed during the period of 16 October, 1992. Conditions of test are stated to indicate amendment to the initially proposed test plan (Attachment 1). A pass or fail status is indicated with explanatory comment as appropriate.

TEST NO.	TEST METHOD	TEST TITLE AND PARAMETERS	STATUS
1.	Container Set-up	Dimensions: 48.2 X 40.1 X 41.1 inches Net Weight: 1021 pounds Gross Weight: 1256 pounds Pallet: 40 X 48 inches	
2.	Fed-Std-101C Method 5008.1	Edgewise Drop (Rotational) Test, Level A. One drop on each bottom edge from 20 inch drop height.	Passed

- |    |                               |   |                     |
|----|-------------------------------|---|---------------------|
| 3. | Fed-Std-101C<br>Method 5005.1 | Cornerwise Drop (Rotational)<br>Test, Level A. One drop on each<br>bottom corner from 20 inch height. | Passed <sup>2</sup> |
| 4. | MIL-STD-648A<br>5.2.8         | Transfer at Sea Shock Test.<br>18 inch flat bottom drop.  | Passed              |
| 5. | Fed-Std-101C<br>Method 5012   | Pendulum Impact Test. One<br>impact on each side at 10 ft/sec<br>impact velocity.                     | Passed <sup>3</sup> |

NOTE 1: Test sequence was reordered to minimize the adverse effect of pallet deterioration on subsequent testing. Test series 3 was performed using a new hardwood pallet, the above specified strapping, and serviceable undamaged CECON container components from test sequences 1 and 2 to determine if this configuration would perform acceptably when subjected to the above drop and pendulum impact testing.

NOTE 2: Non-critical pallet damage resulted in the form of splitting and cracking of bottom boards at the ends exterior to the stringer on the impacted two corners. The test block used to orient the container during test cracked two bottom boards between stringers on opposite container sides. Two stringer ends, one center and one corner on one side, were crushed and cracked. The strapping remained tight. The container remained closed and centered on the pallet. The pallet could clearly be accessed and moved by a forklift truck, therefore; the pallet damage is considered to be non-critical.

NOTE 3: Minor shifting of the upper collar on the lower collar from five sixteenths to five eighths inches occurred, however; the upper collar remained seated and captive on the lower collar. Generally, some minor springing and inelastic deformation occurred on collar corner hinges. Due to a fault of test, one bottom board was sheared off by the pendulum swing because the container was positioned too far forward. The strapping remained tight. The container remained closed and centered on the pallet. The cumulative damage resulting from the pendulum impact test is determined to be non-critical.

NOTE 4: The cap gaskets evaluated in this test were those installed by Cincinnati Case Company, and used in test sequences 1 and 2. Cumulative testing caused compression set from one eighth inch initial thickness to 0.01 to 0.03 inch final thickness.

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**APPENDIX 7**  
**INTERIM REPORT OF TEST**

30 October, 1992

INTERIM REPORT OF TEST FOR THE COLLAPSIBLE EMBARKATION  
CONTAINER (CECON)

The container configuration tested in accordance with the amended test plan consisted of two caps, two 18 inch high collapsible collars, a 4 way partial wing style three stringer hardwood pallet, and 3/4 X 0.023 inch regular duty steel strapping and regular duty strapping seals applied in accordance with MIL-STD-147. All components were either supplied or specified by the Navy, Carderock Division, Naval Surface Warfare Center, Bethesda, MD (Mr. C. Emberger). The steel strapping (NSN 8135-00-281-4069) was applied as two lengthwise and two girthwise bands passing through pallet strapping notches and under deck boards. Each strap joint was formed with two regular duty steel seals each of which received two pairs of notches when sealed. The ultimate tensile strength of the strapping was measured to be 2239 pounds and of the strapping joint was measured to be 2100 pounds. The CECON container components were manufactured by commercial vendor, and forwarded for test by the Carderock Division. The 4 way partial wing style three stringer hardwood pallet (NSN 3990-01-041-8803) was obtained through the Federal Supply System. The container was loaded to a gross load of 1255 pounds and a net load of 1021 pounds using 10 X 10 X 8 inch fiberboard boxes filled with sand to a weight 12 to 50 pounds. Container interior dimensions were L X W X H, 46.1 X 38.2 X 34.2 inches. Assembled container exterior dimensions were 48.2 X 40.1 X 41.1 inches on the pallet.

The assembled and loaded CECON container was subjected to the following tests in the order listed during the period of 26-28 October, 1992. Conditions of test are stated to indicate amendment to the initially proposed test plan (Attachment 1). A pass or fail status is indicated with explanatory comment as appropriate.

TEST NO.	TEST METHOD	TEST TITLE AND PARAMETERS	STATUS
1.		Dimensions: 48.2 X 40.1 X 41.1 Net Weight: 1021 pounds Gross Weight: 1255 pounds	
2.	Fed-Std-101C Method 5016.1	Superimposed Load Test (Stackability with Dunnage) Level A. Loaded 9155 lbs.	Passed

3.	Fed-Std-101C Method 5011.1 (6.2) (6.5) (6.6)	Mechanical Handling Test.  Lifting and transporting by forklift truck Pushing Towing	Passed
4.	Fed-Std-101C Method 5019.1	Vibration (Repetitive Shock) Test: 4.4 Hz, 1.0 in DA, 2 hrs.	Passed
5.	Fed-Std-101C Method 5008.1	Edgewise Drop (Rotational) Test, Level A. One drop on each bottom edge from 20 inch drop height.	Passed
6.	Fed-Std-101C Method 5005.1	Cornerwise Drop (Rotational) Test, Level A. One drop on each bottom corner from 20 inch height.	Passed <sup>2</sup>
7.	MIL-STD-648A 5.2.8	Transfer at Sea Shock Test. 18 inch flat bottom drop.	Passed
8.	Fed-Std-101C Method 5012	Pendulum Impact Test. One impact on each side at 10 ft/sec impact velocity.	Passed <sup>3</sup>
9.	MIL-STD-810E Method 506.3 Procedure I	Rain, Blowing Rain. 5 in/hr rain rate, 40 mph wind on each side for 30 minutes.	Failed <sup>4</sup>

NOTE 1: Test sequence was reordered to minimize the adverse effect of pallet deterioration on subsequent testing. Obviously, stacking and forklift handling tests require an undamaged pallet.

NOTE 2: On the fourth cornerwise drop, the stringer ends on the side intersecting the impacted corner cracked and separated thereby allowing the attached bottom boards to become detached. Other minor bottom board damage such as cracking or breaking off of the board ends on impacting corners and some cracking between stringers also occurred on drops 1-3. Upon completion of the pendulum impact test, a forklift truck accessed the pallet tine pockets, lifted the CECON container, and moved it from all four sides without interference from the cumulative test induced pallet damage. The strapping remained tight. The container remained closed and centered on the pallet. The container could continue on its trip with pallet replacement before being shipped again, therefore; this test induced pallet damage was not determined to be critical or to cause container failure.



NOTE 3: For pendulum impacts, the corner hinges on the impacting face incurred inelastic deformation which caused the hinge assembly seals to open in attaching rivet lines. Notably, the four corner hinges were sprung, the hinge plates through which rivets passed buckled and warped between rivets, and attaching rivets withdrew allowing these seams to open on the bottom collar. Even so, the deformed corner hinges appeared to retain much of their mechanical strength, therefore; with respect to mechanical strength, the deformation is not determined to be critical or to cause container failure. After the rain test, both the upper and lower collars were folded and unfolded without interference from the corner hinge deformation. To a lesser degree, corner hinge deformation and assembly seal opening occurred on the upper collar also.

NOTE 4: Rain, Blowing Rain test results indicate that the CECON container is not watertight at this point in the test sequence. Approximately one quart of leakage is estimated to have entered the container through the eight opened corner hinges, between the top gasket-collar seam, and between the upper-lower collar seam. The gaskets for both the top and bottom caps incurred compression set from one eighth inch initial thickness to 0.01 to 0.03 inch final thickness, consequently; the gaskets did not seal during the rain test.

NOTE 5: The cap gaskets evaluated in this test were those initially provided. The cap gaskets installed by Cincinnati Case Company and used in earlier testing also incurred compression set from one eighth inch initial thickness to 0.01 to 0.03 inch final thickness from much less container testing. The use of a foam rubber gasket such as is installed on the CECON container is not recommended due to excessive compression set and resulting loss of the watertight seal.

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